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TUBA

Stentoro-Phonica,

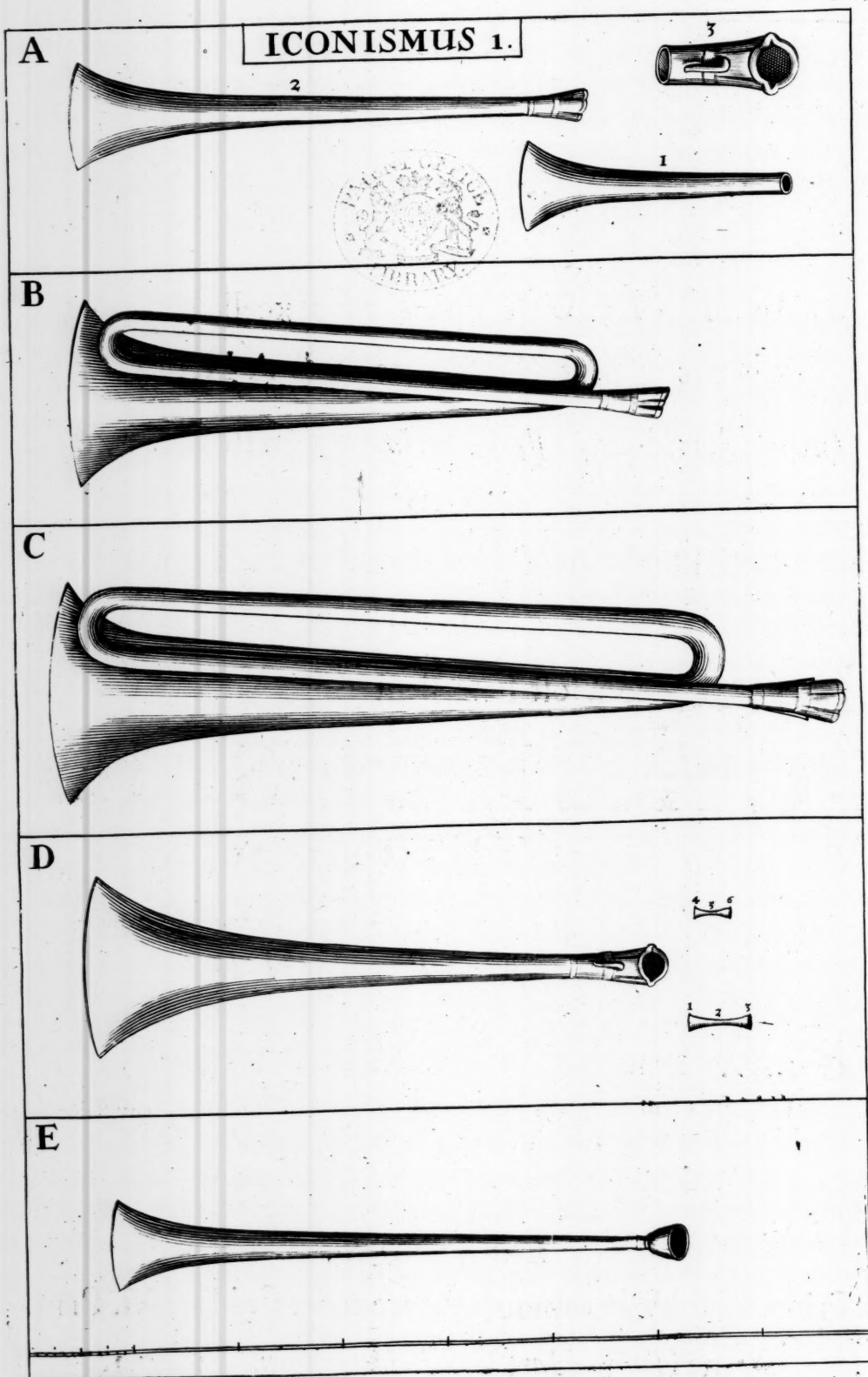
An *INSTRUMENT* of Excellent USE,
As well at SEA, as at LAND;
Invented, and variously Experimented in the Year 1670.

AND
HUMBLY PRESENTED
TO THE
KINGS Most Excellent MAJESTY
CHARLES II.
In the YEAR, 1671.

By S. MORLAND.

The INSTRUMENTS (or SPEAKING-TRUMPETS) of all
Sizes and Dimensions, are Made and Sold by Mr. *Simon Beal*,
one of His Majesties Trumps: in *Suffolk-street*.

L O N D O N,
Printed by W. GODBID, and are to be Sold by M. PITT
at the *White-Hart* in *Little-Britain*. 1671.



30.vi.78

B¹L



A DESCRIPTION of
The TUBA STENTOROPHONICA
In different Figures and Dimensions;

TOGETHER WITH
A brief ACCOUNT of what Tryals and Experiments
have been made of them, both at Sea and Land.



He first Instrument of this kind (though the Invention had been long before digested in my thoughts!) was by my directions made in Glass, in the Year 1670. and is described in *Iconism. 1. Fig. A.* being about 2 Foot 8 Inches in length, the Diameter of the great end 11 liches, and the Diameter of the little end $2\frac{1}{2}$.

*Icon. 1.
Fig. A.
Num. 1.*

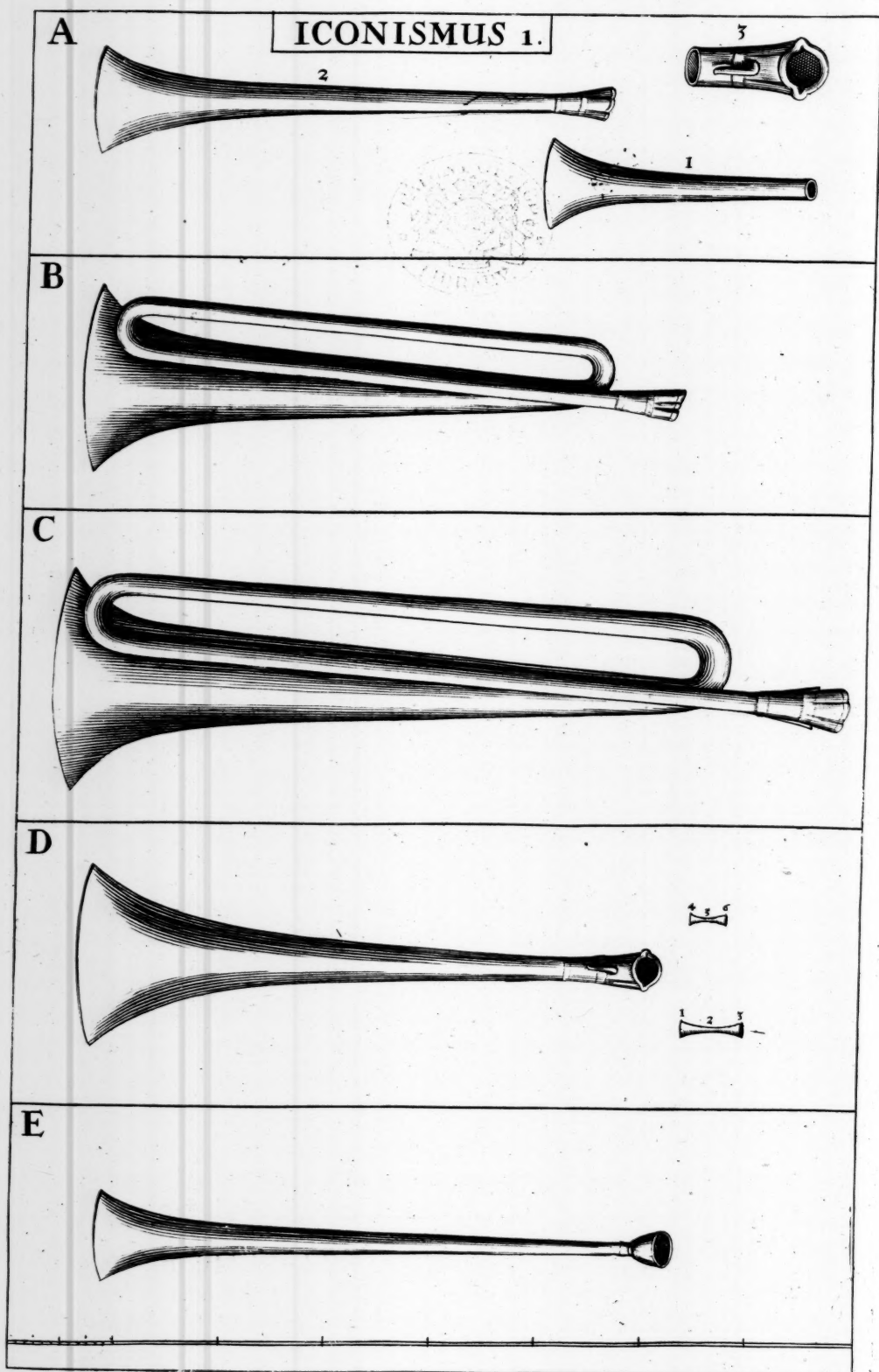
In this Instrument I was heard speaking at a considerable distance, by several Persons, and they likewise were heard by me, and found that it did very considerably magnifie (or rather multiply) the Voice. Whereupon I caused another to be made in Brass, about 4 Foot $\frac{1}{2}$ in length, the Diameter of the greater end 12 Inches, and of the less, 2 Inches; as in *Fig. A. num. 2.* is described. And for the better conveniency of opening and shutting the mouth without losing any part of the breath (the loss of a small part whereof sensibly abates the lowdness of the voice) I caused the Mouth-piece (described *Fig. A. num. 3.*) to be made somewhat after the manner of Bellows, that so by opening and shutting, it might answer the motion of the mouth exactly, and yet be held so close, that it might not lose any part of the breath in speaking.

*Icon. 1.
Fig. A.
Num. 2.*

*Icon. 1.
Fig. A.
Num. 3.*

Of this second Instrument, there were two tryals made very successfully in *St. James's Park*; where, at one time, the Lord *Angier* standing by the Park wall near *Goring-House*, heard me speaking (and that very distinctly) from the end of the Mall near *Old Spring-Garden*: And at another time, His Majesty, His Royal Highness, Prince *Rupert*, and divers of the Nobility and Gentry, standing at the end of the Mall near *Old Spring-Garden*, heard me speaking (word for word) from the other end of the Mall, (though the wind were contrary;) which is 850 Yards, or near $\frac{1}{2}$ of a measured *English* Mile.

Being much encouraged by these Tryals, and by His Majesties most gracious approbation of the Invention, I resolved to make some further Experiments of this Matter, and caused a third Instrument to be made



TUBA STENTOROPHONICA.

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of Copper, in the form of an ordinary Trumpet, (as is described in *Fig. B.*) the length 16 Foot 8 Inches, the Diameter of the great end 19 Inches, and of the little end 2 Inches. *Icon. 1.*
Fig. B.

This Instrument I carried down below the Bridge (being accompanied with a Gentleman or two of my acquaintance) as far as a place called *Cuckolds-point*, and leaving it there in the hands of a Waterman, we Rowed down very near *Deptford*; and there, notwithstanding the noise of Seamen and Carpenters in divers Ships both before and behind us, we heard very distinctly most words the said Waterman spoke in it; whom we judged to be at least a Mile and an half distant from us, and concluded that had the River been free from noise, we might have heard and understood much further.

After that, I caused to be made a fourth Instrument of Copper (as is described *Fig. C.*) about 21 Feet in length, the Diameter of the great end 2 Foot, and of the little end $2\frac{1}{4}$; and of the same Figure and Shape with the former, only it was more exactly wrought. *Icon. 1.*
Fig. C.

I gave likewise directions at the same time (for variety sake) for a fifth Instrument of Copper, the length whereof was 5 Foot 6 Inches, the Diameter of the great end 21 Inches, and of the little end 2 Inches, as in *Fig. D.* As likewise for two smaller Instruments, whose length was each 5 Foot 6 Inches, the Diameter of the great end 10 Inches $\frac{1}{2}$, and of the little end 1 Inch $\frac{1}{2}$. *Icon. 1.*
Fig. D.
Icon. 1.
Fig. E.

The third and fourth of these Instruments were, at one Tryal, heard from off the River over against *Faux-Hall*, to the nearest part of *Batiersey* over against *Chelsey*: And at another, from *Hide-Park-Gate* to *Chelsey-Colledge*; either of which distances was judged to be above a Mile and an half. And by what Tryals I have made of the two least of all, I conceive they may maintain a conference, in a still calm evening, at the least three quarters of a measured Mile.

After this, by His Majesties special Command, the three largest of these Instruments were sent to *Deal Castle*, and there several Tryals were made of them by the Honourable *Francis Digby Esq;* Governour of that Castle; a particular Relation whereof was given under his own hand to the Right Honourable the Lord *Arlington*, His Majesties Principal Secretary of State, in a Letter bearing Date the 14th of *October*, 1671. A Copy whereof His Lordship gave me leave here to insert.

The Copy of a Letter written to the Lord Arlington, His Majesties Principal Secretary of State, by the Honourable Francis Digby Esq; Governour of Deal Castle, bearing Date, October 14. 1671.

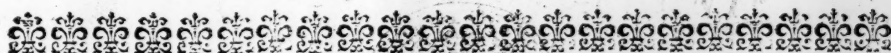
MY LORD,

Sir Samuel Morland having by the Kings Order sent hither three of his new Speaking-Trumpets, I have found them, upon several Tryals to answer, if not exceed what could be expected from them; which I thought necessary to let your Lordship know, as the best way of satisfying His Majesty concerning them. The first Experiment I made, was between Wauern Castle and Deal Castle, with the disadvantage of a side Wind and some noise of the Sea, and yet we heard very distinctly from Castle to Castle, which are about a measured Mile asunder. Since that I have tryed the biggest of the three, which is turned Trumpet-wise, and when the Wind blows from the Shore, we hear plainly off at Sea as far as the Kings Ships usual ride, which is between two and three Miles. This we have done several times, but particularly some days since, we heard from the Castle, to Sir John Chicley's Ship, which lay in the best of the Road. So that without question, they will be of great use in all occasions where it's necessary to give Orders or Intelligence at a distance; but most of all at Sea, where we can give and take the advantage of the Wind, as is best for hearing. We have found likewise, that by laying one of these Instruments to the Ear, the Words are heard more distinctly; and I am confident, there will be found several other ways of improving them to greater perfection, since the improvement has been so considerable at first. I am,

My Lord,

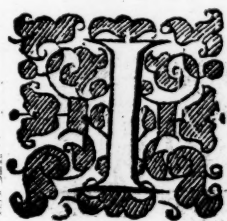
Your Lordships most obedient Servant,

FR. DIGBY.



A SHORT DISCOURSE

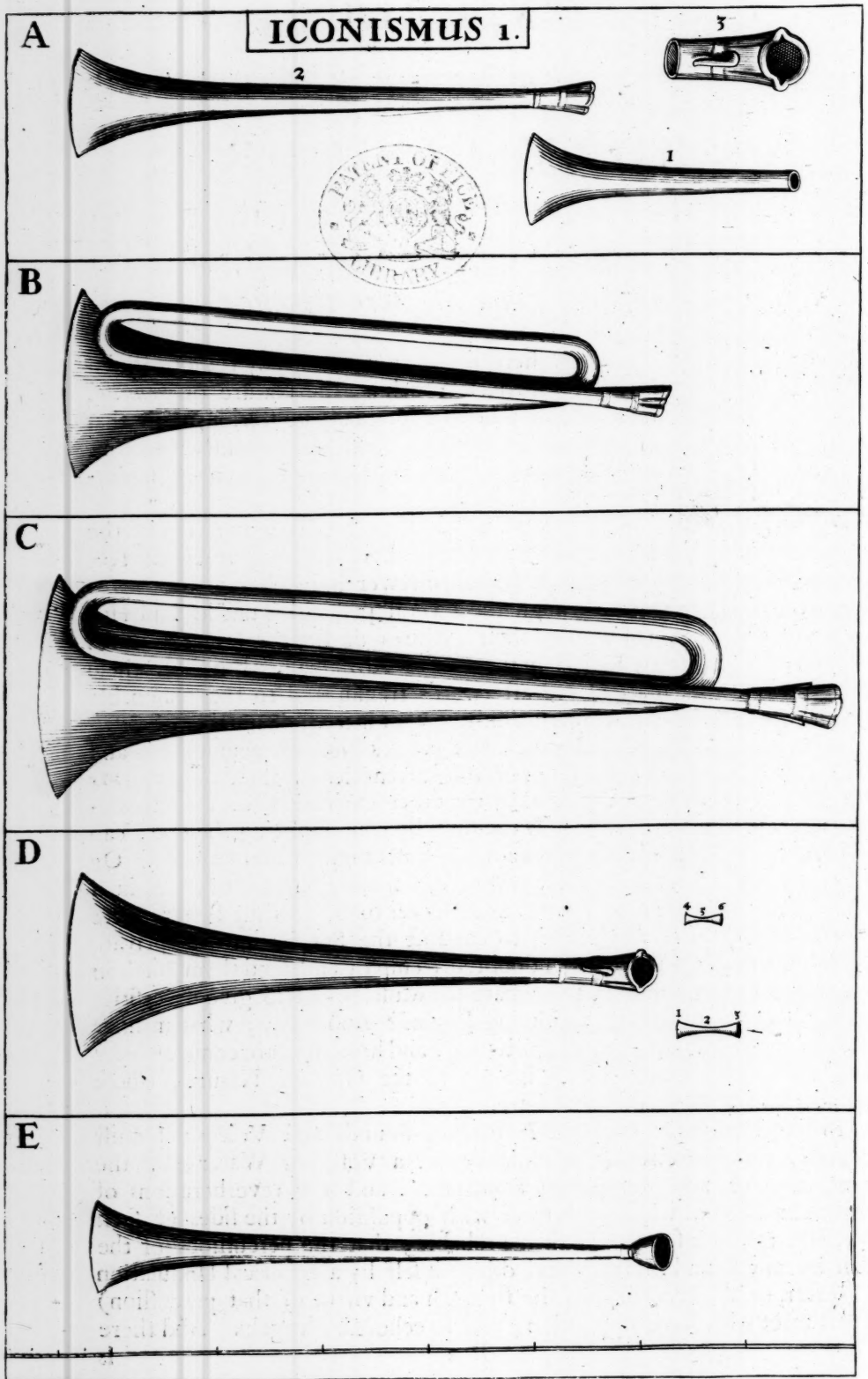
Touching the *Nature of Sounds*, and the manner how (as I conceive) they are magnified, or rather multiplied by the *Tuba Stentoro-Pbonica*.



Shall not here engage my self in any tedious Philosophical Discourse touching the Nature of *Sounds*, forasmuch as I believe it equally mysterious with that of *Light* and *Colours*, and consequently too fine and too subtil a thing for humane reason and understanding to comprehend.

True it is, as to the act of Vision, that by the help of curious Anatomists, we may trace the Refracted Rays of visible Objects (more or fewer in number as the *Pupilla* is dilated or contracted) through the several pellucid Tunicks and Humours of the Eye, till we find their Pictures or Images (their postures only inverted!) fairly lodg'd in the *Tunica Retiformis*. But how these Images or Representations are afterwards transmitted to the reasonable Soul? whether by the mediation only of that incredible number of *Capillamenta* (or small Threds) of which the Optick Nerve is composed? and if so, how the various percussions of the extremities of those *Capillaments* in the *Tunica Retina*, are repeated by the other extremities of the same *Capillaments* in the Brain? and how the Soul by contemplating the one, can discern the other, with so great a variety of Figures and Colours? Or whether that immortal Fire, in the act of Vision, makes any use of the Animal Spirits (those nimble *Mercurys* of which it has such plentiful Repositories in the Ventricles of the Brain) to conduct the Species into its private Recesses there, as she does undoubtedly employ and send them forth in greater and lesser numbers, to animate the Muscles, and so give diversities of Motions to our bodily and living Engins? And lastly, what manner of Creatures those little active Spirits are? and how they are commanded? and how they obey? is best known to the God of Nature, whose wonderful Workmanship we all are.

In like manner, as to the Nature of Sounds and Voices; I must confess, that the circular Undulations of a Vessel of Water, by the percussion of any part of its Superficies, and the reverberations of those Undulations when they meet with opposition by the sides of such Vessels, makes it seem more than probable, that the percussions of the Air by any Sound, spreads and dilates it self by a spherical Undulation (greater, or less, according to the strength and virtue of that percussion) till it meet with some opposition, and so echoes back again. And there



TUBA STENTOROPHONICA.

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is great reason to believe that Voices being first modulated and articulated by the *Glottis* of the *Larinx*, and the several parts of the Mouth, make spherical Undulations in the Air, till they meet with the Acoustick Organ, whose excellent Fabrick we may indeed with admiration contemplate, and give a guess for what Uses each part was ordained, namely the *πλεγμα, κορυφή*, and *πρὸ ἀκροῦς*, as likewise the *Tympanum*, together with the *Malleus*, *Incus*, and *Stapes*: But what manner of Images or Species such Percussions make; with such an infinity of distinctions and varieties? and how they fly about like Atoms in the Air? and are to be found in each point of the *Medium*? (and anon vanish into nothing?) and by what stupendous agility they are conveyed to the Soul? and how that does to receive so many millions of messages from without? and to dispatch and send out as many more from within? and that in so short a space of time? the more we torment our thoughts about it, the less we understand it, and are forced to confess our Ignorance. *Ἐὶ δὲ τῆς διανοῆς ἐκδέναι π, ὁ δὲ πρὸ ἐκδέν ὕψους καθὼς δὲ γινώσκ.*

All therefore that I shall adventure to say upon this Subject, is only to give the Reader a short account of what Observations I have made, relating to this Instrument; and where I attempt to give a reason, it shall be with all submission to Men of greater Learning and better Understanding.

I. I do find that a small Tube (as for example, that of an ordinary Trumpet) does not at all magnifie the Sounds, or Words, or Syllables; but on the contrary does much lessen and diminish it.

II. I do find it necessary, that the Diameter of the least end of one of these Instruments must be equal to (if not greater then) the Diameter of the Orifice of the Speakers Mouth; and that what it wants of that, so much the less does the Instrument magnifie (or multiply) the Voice. For Example: I made 2 Mouth-pieces for the Instrument in *Icon. 1. Fig. D. num. 1, 2, 3, and 4, 5, 6.* the Diameter of the middle part (2) was an Inch, and of (5) about $\frac{1}{2}$ of an Inch, but found that the one did not magnifie $\frac{1}{2}$, nor the other $\frac{1}{4}$ so much as the same Instrument with a Mouth-piece like unto that in *Icon. 1. Fig. A. num. 3.* And indeed it seems reasonable, that the Mouth of Man being an Instrument that Nature has already fitted for the work; to apply to it an Orifice less than its own, is, in truth, to put a check to the motion of the Air and Breath, and consequently to lessen the Sound of the Voice.

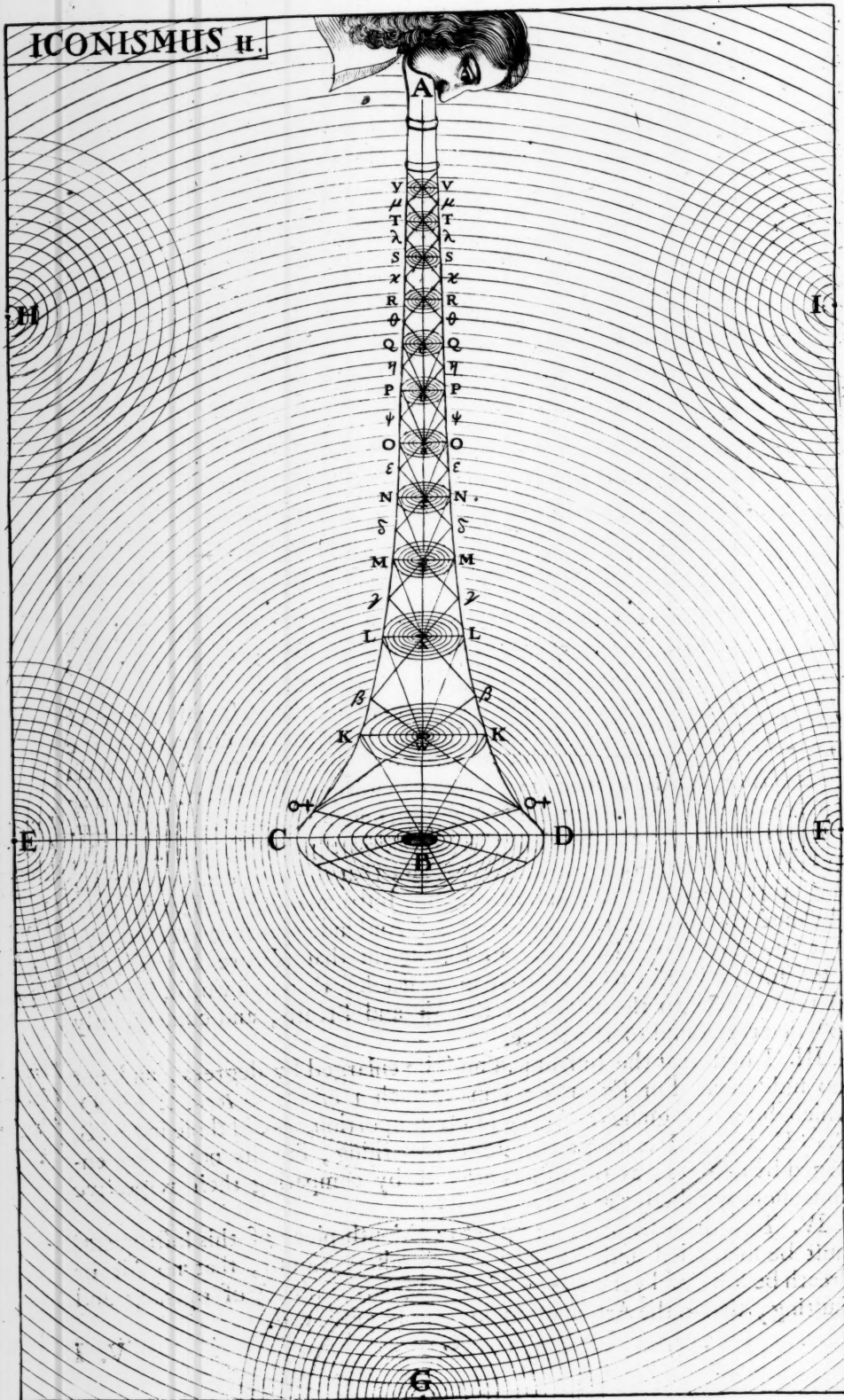
III. I find that the Instrument must be enlarged by degrees, and not too suddenly. For Example: I made such a one as in *Icon. 1. Fig. D.* which did not magnifie the Voice in any proportion, as did those in *Fig. B, C, or E.* which I cannot attribute to any thing, but its not being enlarged by degrees, as the others are; as by comparing their respective dimensions will better appear.

IV. That the least end, or rather the Mouth-piece of this Instrument, must be so applied and fitted to the Speakers Mouth, that no Air or Breath be lost, and yet that the Mouth have free liberty of opening and shutting, that so the Articulation be entirely preserved.

C

V. I

ICONISMUS II.



TUBA STENTOROPHONICA.

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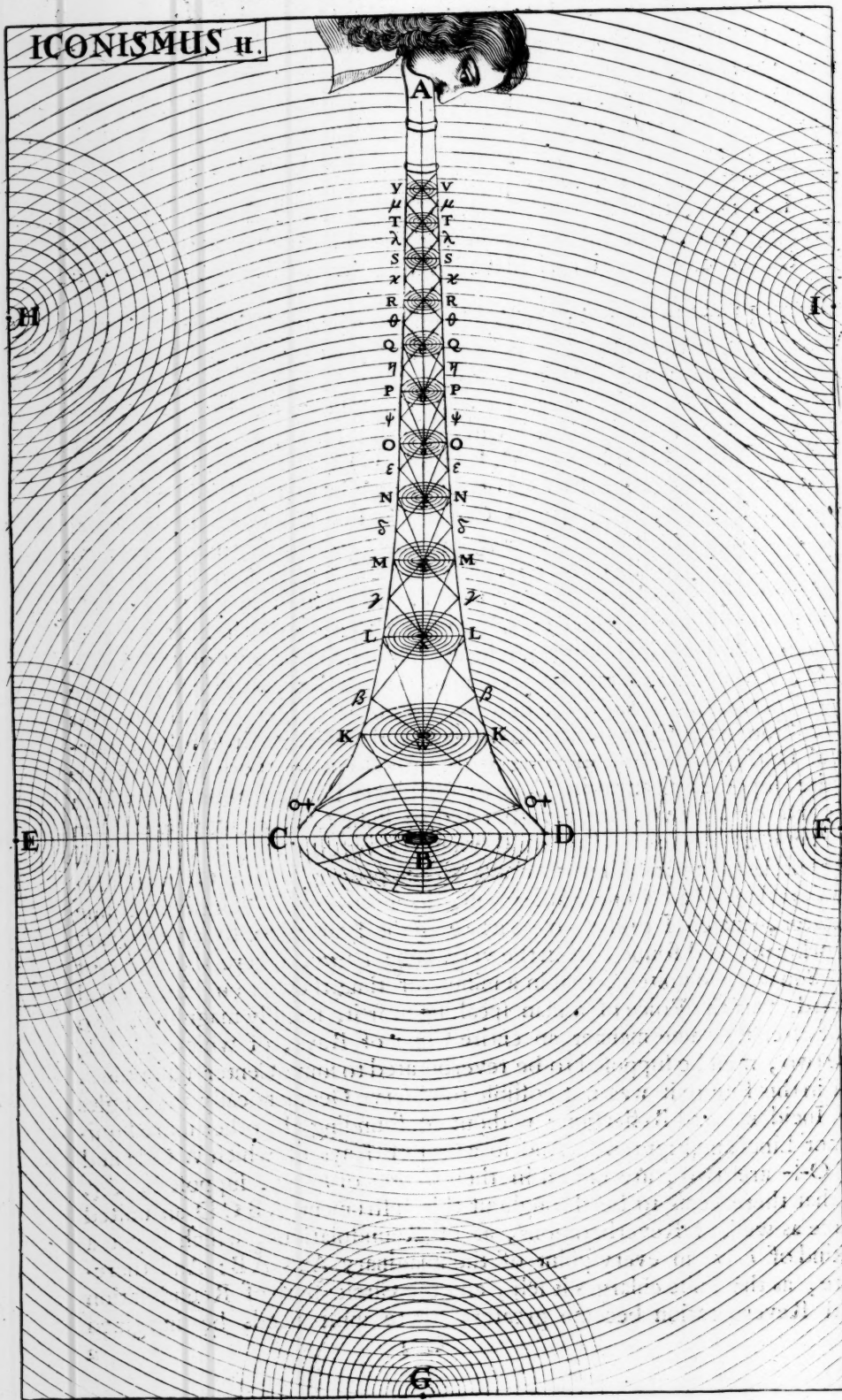
V. I do find by divers Experiments, that the *Polyphonismus* (that is to say, the *Focus*, or Point where the Voice is most magnified or multiplied) is the Center of its greater Orifice, as in *Iconism*. 2. *Lit. B.* And from that point, to the Center of the least Orifice (which is indeed the whole length of the Axis) it is magnified less and less, in proportion, as the Diameter is shortened. *Icon. 2. Lit. B.*

VI. I find, that the turning and winding of this Instrument, either Trumpet-wise, or in any other Circular Figure, does not at all prejudice it: On the contrary, I do believe it rather strengthens and confirms the Voice.

VII. I humbly conceive (with submission to better judgments) that the Voice, as it is transmitted through this Instrument (*A B C D*) from the Mouth *A*, endeavours all the way, to spread and dilate it self by spherical Undulations; but finding opposition on every side, makes a percussion in every point of each imaginary Circle of the Tube, viz. *V V, T T, S S, R R, Q Q, P P, O O, N N, M M, L L, K K, C D, &c.* and so reundulates back to the respective Centers of every such imaginary Circle; That is to say, The Circle *Q Q* to its Center *c*; The Circle *P P* to its Center *b*; The Circle *O O* to its Center *a*; The Circle *N N* to its Center *z*; The Circle *M M* to its Center *Y*; The Circle *C B* to its Center *B*, &c.

Again, it is to be supposed, that the Percussion in the Circle *Q Q* being reundulated to the Center *c*, makes there a much stronger percussion than that which was made in any single point or part of the Circle *Q Q*, forasmuch as it may be presumed, that all the percussions that were made in the Circle *Q Q* are now united in the Center *c*; and that this percussion in the Center *c* would again spread and dilate it self by a spherical Undulation; but meeting with opposition in every point of the Tube (suppose *u u*) an entire Cone of imaginary Rays of Sound, of which *c u* and *c u* are two, are reverberated to some Center (suppose it *b*) in the same manner as the Rays of the Sun are reverberated from a polish'd Superficies of a parabolical Concave to its proper *Focus*; Of which reverberation I had a fair Experiment, in a parabolical Concave of fine Pewter, which I caused to be made in the Year 1670. by a very exact Workman, and found that in the very same *Focus*, where the Rays of the Sun were so united, that in a minute of time they set on Fire a Deal Board, was the Voice of a man speaking near it, sensibly magnified. So that after the same manner an entire Cone of Rays, of which *b d*, *b d*, are two, must be supposed to be reverberated to some Center (suppose *a*, for in this Figure it was not possible to observe Geometrically the Angles of Incidence and Reflection, without confounding the other more significant Lines and Figures.) And so a Cone of Rays, of which *W O* + and *W O* + are two, are united in their Center or *Focus*, suppose *B*, &c. so that there seems to be throughout this Instrument *A B C D* an united force as well of Reverberations, as of Reundulations, which beget a kind of *Focus* in every point of the imaginary Axis *A B*: And therefore, as the Tube enlarges it self, and the Circles both of Reundulation and Reverberation become greater, there must needs be imagined

ICONISMUS II.



a greater number of reundulating Circles, and reverberating Rays to meet in each respective Center and *Focus*, whereby the same Voice is prodigiously magnified and augmented.

Wherefore, if this Instrument *ABCD* were cut off in the points *MM*, it would not magnify $\frac{1}{2}$ of what it does at the whole length, which I have sufficiently experimented, and am entirely satisfied therein.

And as to the points of Reundulation and Reverberation, my opinion was very much confirmed to me by a late Experiment I made with a Vessel of Quicksilver, of the same Figure with this *Iconismus* *HEGFI*, in the midst whereof were small thin Hoops, or pieces of wood bent and fixed in the same Figure as is *CKOVAVOKD*, being closed at the end *A*, and open at the end *CD*. Into this Vessel I put Quicksilver enough to cover the whole Figure, and consequently the Figure *ABCD*. And then striking the Quicksilver smartly in *A* with the end of a stick, it begot a numberless number of Curvilinear Undulating and Reundulating Figures, not unlike to the Figures *VV*, *TT*, *SS*, *RR*, &c. from the point *A*, to the point *B*, which were reverberated from the sides *ANC*, and *AND*, as they were driven along one by another.

This Experiment, together with another which I lately made, by carrying one Ear along the Line *EF* and *WG*, with what exactness I possibly could, whilst a Gentleman did me the favour to read some pages of a Book, with an even tone, in each of the four Instruments *B*, *C*, *D*, and *E*, in *Iconism*. 1. separately and distinctly: At which time I plainly found, that as my Ear advanced towards the point *B*, the Voice was sensibly magnified; but as it was removed towards *W*, it was somewhat abated; and as it was removed either towards *C*, *D*, or *G*, it was abated two, three, four, five, six, and more degrees; made me conclude for certain, that in every point of the imaginary Axis there is a *Focus* or *Polyphonismus*, but that the principal and chiefest *Focus* where the greatest *Polyphonismus* of all is, that is to say, the point where the Voice is most of all magnified or multiplied; is *B*.

This *Focus* (or *Polyphonismus*) being now no longer imprisoned in the Tube, dilates itself by spherical Undulations into the *Medium* (as in *Icon*. 2. may more plainly appear) till such time as it meets with some opposition; as for example, let us suppose it in the points *H*, *E*, *G*, *F*, *I*, from which points, and innumerable others, it is reundulated, multiplied, and reverberated throughout the Sphere of its activity: For by how much stronger the percussion is in *B*, so much greater is the Sphere of Undulation and Reverberation, and consequently the Voice is heard at a greater distance.

And that such Reundulations and Reverberations do exceedingly magnify or multiply Sounds, I cannot but recommend to the Readers contemplation, a famous Experiment made in the Year of Our Lord 1615. by one *Bernardus Varenius* (a sober and learned Writer) as he himself relates it in his *Geographia Generalis*, *Lib. 1. Prop. 41.* who, after he had with much pains and difficulty climb'd up to the top of *Carpathus*, a Mountain of *Hungary*, (whose perpendicular height he judged to be

a German Mile, and above all Winds and Motions of the Air) he discharged a Pistol, which made at first no greater noise, than if he had snapt a stick in sunder; till after some small space of time, being dilated, it waxed greater and stronger, and filled the Woods and Dales beneath. But descending through the annual Snows, towards the lower part of the Mountain, he discharged a second time, and the noise was so horrible, that it exceeded the Report of the greatest Cannon; insomuch that he feared lest the whole Mountain would have fallen with him. This noise lasted about $\frac{1}{2}$ of an hour, till it had been multiplied and reverberated from the most abstruse Caverns of the Mountain, &c. as is better expressed in the Authors own words, *Explosi in ea summitate scopetum, quod non majorem sonitum primo præ se tulit, quam si ligillum vel bacillum confregissem, post intervallum autem temporis murmur prolixum inva-
luit, &c.*

Water
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So that from this Experiment of *Varenus*, we are to conclude with him, That the percussion of the Air made by the first discharging of his Pistol on the utmost top and sharpest point of the Mountain, being dilated by a spherical Undulation, and meeting with no Objects to reundulate it, was at the first scarcely heard by him who discharged it; whereas the second Report, being nearer to the Caverns and Woods beneath, were suddenly and prodigiously multiplied and reverberated.

VIII. But in the last place, as to the demonstrative part of this *Tuba Stentoro-Phonica*, together with the exact Figure and Dimensions of it, That is to say,

*“What is that Right-lined, Curvilineal, or mixt
“Figure? And what are its exact Dimensions?
“And what the Sphere of its Activity? That
“best and most magnifies Humane Voyce in
“Syllables, Words, and Sentences?”*

is a new Problem, which I humbly propose to the learned Philosophers, and Criticks of this our Age, as a thing that merits their Studies and Contemplations, hoping that some one or other of them, either at his own, or his Princes charge, may happily find a way how it may be clearly solved and demonstrated, whereby the Invention may come to be of greater use and benefit to Mankind, than from this first Adventure of mine could reasonably be expected.

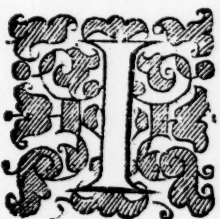
— Et erit mihi magnus Apollo.



A

Brief Account of the Manifold USES
OF THIS
TUBA STENTOROPHONICA,
OR
LOUD-SPEAKING-TRUMPET,
Both at SEA, and LAND.

I. *At Sea.*


I.  N a Storm, or in a dark night, when two Ships dare not come so near one to the other as to be heard by any mans ordinary Voice; I conceive it may be of great use, that by this Instrument they may with great facility speak and discourse together at half a mile or a miles distance, or more, if occasion require, especially if alternately they take the advantage of the Wind. And if that be so strong, that but one of the Ships can have any opportunity of speaking with the Wind, the other may answer by signs, though directly against it.

II. In a Storm, it is of great use in a single Ship, that one mans Voice giving Orders for governing and steering the Vessel, may be heard distinctly by all the Mariners. Of which His Majesty, who perfectly understands all Maritime Affairs, is so sensible, that He has already given order for some of these Instruments of the smaller size (as judging them most useful) to be made and put into several of His Royal Ships. And it is to be believed, that when the use of them shall be more publickly known, few Ships (whether Men of War or Merchant-men) will go to Sea without them.

III. In Calm weather, an Admiral may give Orders to his whole Fleet, though they lay two or three miles about, without sending out Boats and Messengers from Ship to Ship.

IV. In cases of great Expedition, Orders may be given from such Forts as the Castle of Deal, &c. to any one or all the Ships riding in the Road. And if it be a matter of secrecy, it may be spoken in Cypher, being before hand agreed on between the Governour of such a Castle, and the Admiral or chief Commander aboard those Ships.

II. *At Land.*

I.  N case a Town or City be Besieged, and so close girt about, that there can be no message sent in; by this Instrument at one, two, or three miles distance, they may be told that there is Relief coming, and what number, and when they are to expect them, and how they are to behave themselves upon their approach; and this by speaking in

D 2

Cypher,

Cypher, as is before mentioned. And so on the contrary, may the Besiegers make as good use of this Instrument to threaten and discourage the Besieged, not only the Officers and Souldiers on the Walls and Bulwarks, but all the People and Inhabitants, how great and spacious soever the Town or City be.

II. A General may himself speak to his whole Army, though forty or fifty thousand men or more, either to give Orders to his Commanders and Officers, or to encourage and put life into his common Souldiers.

III. Whereas now a Herald at Arms making a Proclamation, though of never so great concernment and importance, can scarcely be heard by above thirty or forty Standers-by; by the help of this Instrument he may be heard very distinctly by many thousands. And the Case is almost the same in such Courts of Judicature as the *Kings-Bench* in *Westminster-Hall*, &c. where many of His Majesties Subjects are punished for not hearing the Call of the Common Cryer, further, and beyond the sphere of activity of the said Cryer's speaking Organ.

IV. An Overseer of Works, of what kind soever, may by this give Orders to many hundreds of Workmen, without once removing his station.

V. In case of great Fires, where usually all people are in a hurry, the Officers and Commanders may by this Instrument so govern the Assistants, as to prevent disorder and confusion, and consequently may save a Town or City from perishing.

VI. In case a number of Thieves and Robbers attack a House that is lonely, and far from Neighbours, by such an Instrument as this, may all the Dwellers round about, within the compass of a Mile or more, be immediately informed, upon whose House such an attack is made, the number of Thieves or Robbers, how armed and equipped, what manner of persons, with the colour and fashion of their Habits, and by what way they have made their escape, with any such like circumstances; whereby they would certainly know, with what strength to come upon those House-breakers, where readily to find them, or which way to pursue them. No particular whereof can be performed by either Drum, Trumpet, Bell, or any other Engin or Instrument, hitherto in use.

These and many more may be the Advantages of this New Instrument, as it is already invented: And I do not doubt, but were the Dimensions of the *Fig. C.* in *Icon. 1.* sufficiently enlarged, it might render a Voice audible at the least eight or ten Miles, either at Sea or Land, with a favourable Wind. And what further additions to, and improvements of this Invention may hereafter, by the Art and Industry of Ingenious and Learned Men, be found out, Time and Experience will better shew. In the mean time, if the World shall kindly accept these my first Endeavours, it will be an Encouragement to me hereafter to produce others.

SOLI DEO GLORIA.

FINIS.

